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PHOTO MISSION GUIDELINES AT SEA

by

Hannah J. Bernard, Morgan S. Lynn,
Wayne L. Perryman and Jay Barlow

ADMINISTRATIVE REPORT LJ-88-22

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INTRODUCTION

The purpose of this document is to assist those members of the Photogrammetric Remote Sensing Group (PRSG), flight crew, scientific, and ship's personnel involved in helicopter operations aboard the R/V David Starr Jordan during the Monitoring of Porpoise Stocks (MOPS) cruises. The monitoring project was designed to detect changes in relative population sizes of dolphin stocks incidentally killed in the tuna purse-seine fishery in the eastern tropical Pacific Ocean (ETP).

OBJECTIVES

The principal objective of the PRSG is to provide support to the MOPS project by collecting photographs that will be used to calibrate school size estimates of dolphins detected by shipboard observers. In addition, high resolution imagery will allow us to document school structure and determine certain reproductive parameters. In order to enhance cooperation between the different groups that must interact during helicopter operations, the PRSG has developed the following guidelines.

MATERIALS AND METHODS

Personnel

There are essentially four groups involved in flight operations: PRSG members, ship's crew (safety team and ship's officers), helicopter crew, and other scientific staff (cruise leader and observers). Coordinating the interactions of these four groups is critical to the overall success of the mission. PRSG members are responsible for initiating flight operations by contacting the helicopter pilot and mechanic, the cruise leader, and the Officer of the Deck.

The Officer of the Deck is responsible for the "15 minute call-out", which is announced over the ship's intercom. It is during this 15 minute period that the safety crew can suit up and assume their stations.

During flight operations, the cruise leader acts as liaison between the observers on the vessel and personnel in the helicopter. For example, if a school has been sighted, the cruise leader will keep track of its whereabouts and notify the PRSG group once they are airborne. For safety reasons, it is critical that the cruise leader remain on the bridge whenever the helicopter is in the air. When a school is being photographed, the cruise leader should ensure that all 6 observers are prepared to make school size estimates. The helicopter mechanic will also remain on the bridge during a photo mission to monitor the helicopter's location on the ship's radar.

Hardware

The helicopter used for this project is a Hughes 500D, operated by NOAA's Office of Aircraft Operations. It deploys from a removable helipad attached to the stern of the D.S. Jordan. Two modified U. S. Naval aerial reconnaissance cameras are attached to a camera mount on the underside of the aircraft, and are electronically operated from inside the craft. These cameras have excellent optics, fast shutter speeds (up to 1/3000 second), and rapid cycle rates (up to 8 frames/second), as well as an image motion compensation system which eliminates the loss of resolution caused by the forward motion of the aircraft.

Two hand-held, 70 mm cameras (Agiflite and Hasselblad) are always carried inside the helicopter. These cameras are especially useful on small schools and when midday sun prevents optimal vertical photography.

HELICOPTER OPERATIONS PLANNING

Three elements must be coordinated during helicopter operations: safety, flight scheduling and hardware.

Safety

The team leader of the PRSG will decide if environmental and lighting conditions are suitable for photography. The decision on whether conditions are safe enough for flight operations, however, is made by unanimous agreement among the Officer of the Deck, the cruise leader, the team leader of the PRSG, and the pilot. The established guidelines for helicopter operations at

sea are conservative and allow for a considerable margin of safety. PRSG members are advised not to fly if concerned about the safety of the helicopter operations and to express these concerns to the cruise leader. Under no circumstances are you required to fly if you feel the operation is unsafe.

Due to the weight and drag of the camera system, the crew of the photo missions will consist of a maximum of three people: the pilot and two photographers. When PRSG members are comfortable that the photographic systems are working well, the cruise leader may participate as recorder and hand-held camera operator (back seat position) for a flight or two to become familiar with our operation. It is very important that the cruise leader understand from first-hand experience what a photo mission is like.

Flight Scheduling

The success of both oblique and vertical photography is inversely related to sea state. This is the result of two factors: as sea state increases, the amount of light that penetrates the surface is reduced. Also, the size of the glitter pattern caused by the reflection of the sun increases with increasing sea state. This reflection obscures all that is below it and thus reduces the useful area of the photograph. As the sun nears its zenith, its reflection moves directly beneath the helicopter and makes vertical photography almost impossible in Beaufort sea states greater than one.

Environmental conditions at sea are highly variable and each flight must be judged on an individual basis. When in doubt about whether or not a photographic mission will be able to gather useful imagery or not, make the flight. The cost of fuel and flight time are negligible in comparison to the value of lucky shots obtained when variable weather breaks. **Under no circumstances should anyone's safety be compromised.** The following general guidelines should be helpful under most circumstances, however, there are always exceptions.

Sea State

Beaufort 0-2 - If the sun is not obscured by clouds, and the sea state is 0 or 1, chances of successful photography are excellent nearly all day. During these conditions, it is important to remain airborne as much as possible. Fly a 2 hour search mission during the best picture taking times: 1 1/2 - 2 hours after sunrise and 1 1/2 hours before sunset. (The lighting seemed best during September from 0800 to 1030 or 1100 hrs, then again between 1300 to approximately 1630 hrs). Between these two time-windows, fly only when a dolphin school is sighted by the observers. When the sun is

high in the sky, the vertical cameras may still be usable, but expect to use the hand-held cameras on smaller or more compact schools.

Beaufort 3 - During this sea state, highly variable environmental conditions (e.g., lighting) can make or break the mission. A low Beaufort 3 looks very different from a high Beaufort 3. Fly search missions in the morning and evening if the swell is minimal (i.e., less than 4 feet) and the lighting is good. Photograph all observer-sighted schools whenever lighting conditions are adequate. In most cases the vertical cameras won't be of much use during the 1 1/2 hours before and after local noon. Again, hand-held cameras will work well on small schools during this time. It may be useful to record the actual wind speed in the log (ask for it from the bridge) until you are comfortable identifying the various "shades" of Beaufort 3.

Beaufort 4 - Fly only if a school is sighted and conditions are deemed suitable for photography. Unless environmental conditions are very good, neither the vertical nor the hand-held cameras are of much use during the 1 1/2 hours before and after noon and 1 1/2 hours before sunset.

Beaufort 5 - We have not had any experience flying during this sea state. We believe the conditions would be very poor for photography, and the observer sightings during this sea state are not used in analyses. Do not fly photographic missions.

When not flying the routine search missions described above, the PRSG members and helicopter crew are considered "on stand-by". At least one member of the PRSG must remain on the flying bridge to monitor when the observers sight a school. If conditions are appropriate for photography, do not wait to find out what kind of school has been sighted. Immediately alert the other groups involved in flight operations and get ready to fly.

Modifying Conditions

Clouds - Thick clouds make the water very dark because light penetration of the water is limited. Marine mammals do not contrast as well in darker water and are very difficult to see. To adjust for this, it is necessary to slow the shutter speed on all cameras considerably. Clouds can also reduce the ceiling, sometimes to a point too low for the vertical and Agiflite cameras to be focused. Rain can damage our cameras and other electronic equipment. Therefore, flights should not be made in the rain. Thinner or higher clouds tend to spread out the glare over the sea surface, especially around noon. This diffuse glare can be

almost as impenetrable as glitter, which results from bright sun reflection on roughened seas.

Swell - If a heavy swell is running (i.e., 7 feet or greater), the helicopter may not be able to fly even if photographic conditions are good and sea state is acceptable. Big swells coupled with wind can increase the sea state and reduce your ability to collect good imagery. The pilot will be the best judge concerning flight operations safety when there are large swells.

School size and distribution - To successfully photograph cetaceans, the school must be distributed such that most of the school can be photographed in at least one pass. We should have at least 3 good passes for image interpretation, and increasing number of passes beyond this increases our chances of getting all animals in a school. The absolute size of the school is not as limiting a factor as is the distribution of animals in the school. When photographing large schools near the ship, it is best to shoot the imagery immediately upon finding the school. The approaching ship usually splits the school in two to three diffuse, quickly separating groups. To minimize this problem, the helicopter must be in the air as soon after the school is sighted as possible.

Hardware

The team leader of the PRSG on each leg is responsible for ensuring that the cameras are ready for each mission. There is often much to do, and some activities must be delegated. Make the decision regarding who is responsible for what at the start of each leg of the cruise. Don't hesitate to switch roles from time to time so that both PRSG members can do every task.

If possible, the cruise leader should assist as a "third pair of hands" to set up the helicopter for the first flight of the day and to take equipment in at the end of the day. The cruise leader may also help the pilot and mechanic store the doors of the helicopter and lower the platform rails prior to takeoff. The helicopter and its equipment are the responsibility of the pilot and mechanic.

To ensure that each photo mission progresses smoothly, the following activities must be accomplished:

1. The vertical cameras must be checked and advanced between missions and just before a mission, to prevent film jams.

2. Batteries for the Hasselblad camera must be replaced with fully charged batteries once a week. The Agiflite uses the helicopter as its power source, but backup batteries should be ready for this camera in case of malfunction.

3. Film for the vertical cameras must be given at least 12 hours to reach room temperature before opening the canister. Try to anticipate film changes and have defrosted film ready. It is better to let film stay at room temperature for a few days than to lose a flight because film is not ready.

4. Test both cameras regularly with black and white film to ensure that the cameras are operating properly. If possible, test each camera when a film change is due.

5. Start each mission with at least 5 fluorescein dye markers.

THE PHOTO MISSION

The photo team consists of two PRSG members with some unique and some shared roles.

Front Seat

The observer in the front seat directs the helicopter on photo-passes and remotely operates the vertical cameras on these passes. Because the forward team member has the best overall view of the school as it passes under the helicopter, it is his/her responsibility to direct the pilot in guiding the aircraft during photography. This person must adjust for forward motion compensation using the altitude and airspeed dials on the control box, and note whether or not the whole of the school passed underneath the camera's field of view. This information must be noted on the front seat form. In addition, the forward observer often gets the best view of the configuration of the school. A sketch of this will be extremely valuable when analyzing the photographs and should be included for each pass.

Back Seat

The back-seat observer will operate the computer data acquisition system during photo passes. This system records the time, sighting number, pass number, altitude, environmental conditions, and camera configuration. If the system fails, that observer will record this information by hand. Communication between the front-seat and back-seat observers is critical. The individual in the back seat must know when the aircraft is over

the main body of the school (if there is one). In addition, if the helicopter is changing altitude significantly during the passes, the front seat operator must be notified. It is the responsibility of the back-seat observer to check the vacuum (placed between the two back seats) during the mission. This observer can also note if parts of the school are passing too far out of range of the cameras.

The back seat individual also tosses the dye marker out of the helicopter. Anticipate this activity and let the dye markers go when the animals are directly below the helicopter. Allow for wind velocity and direction when throwing the dye markers. They appear to arc backward from the direction of flight because of the helicopter's forward motion. Special care must be taken to throw them straight down and away from the skids and the tail rotor.

Shared Responsibilities

Finding and staying with dolphin schools is hard work and requires considerable concentration. There is some variability in the skills required to see and track schools. The major factor however, is how hard you work at it. After sighting a school, alert the other photo-mission members aboard the helicopter, and begin recording pertinent information, such as environmental conditions, etc. Continually scan for the school, keeping it in visual contact. On some occasions the rear observer will have to guide the helicopter over the school, particularly during passes using the hand-held cameras.

Remember, SEARCHING IS DIFFERENT THAN LOOKING. Looking is a relaxing experience. Searching is tedious, hard work.

Small-format photography (hand-held cameras) is also a shared responsibility. Photographic passes can be made on all schools with the 70 mm cameras unless the configuration of the school is too widespread. These cameras are also very useful when glare is severe and the vertical cameras' photographic footprint becomes reduced. When shooting hand-held cameras, shoot as close to vertical as possible. Animals appear most clearly underwater when they are almost directly below. Notes on school configuration during a hand-held pass are essential for image interpretation. Either observer can photograph while the other is taking notes. Be sure to shoot frames of the sky or the inside of the aircraft between passes.

At the end of each day, the fittings on the camera mount should be lubricated and covered. Data forms, hand-held cameras and other removable gear must be brought inside daily and between missions if it looks like rain is imminent. Be certain not to leave anything in the helicopter on rainy days.

Photographic Techniques

Always increase frame overlap (by pushing the "extra picture" button) when using the vertical cameras.

Until further notice, the normal exposure settings, film and filter types for photographic sampling:

VERTICAL CAMERAS

FILM	LIGHTING	EXPOSURE (f4 or f4.5)	FILTER
2448	Bright	/500	UV or none
2448	Very Bright	/800	UV or none
2448	Cloudy	/500	UV or none
2402 or 3404	Bright	/1200	yellow
2402 or 3404	Cloudy	/800	yellow
2402 or 3404	Bright	/2000	none
2402 or 3404	Cloudy	/1200	none
3412	All	/500	light yellow
3412	Bright	/800	none
3412	Cloudy	/500	none

HAND-HELD CAMERAS

AGI Ekto 200	Bright	f2.8/2000	UV or none
	Cloudy	f2.8/1000	UV or none
HB Ekto 200	Bright	f5.6/500	UV or none
	Cloudy	f4/500	UV or none
HB K64	All	f2.8/500	UV or none

Altitude - Higher flights mean less resolution for a larger area. In general, a cruising altitude of 800 ft is a good standard height to search from and photograph, especially if the ship is several miles or greater from the school. Lower flying usually affects the school's behavior, and hence, the observers' impressions of it. This change in school behavior could even affect observer school size estimates, a result we must avoid. If the school is large or spread out over a very large area, go up to 1000 ft. The imagery from the KA-45 may be less useful, but that from the KA-62 is still quite valuable. If the school is relatively compact, drop to 700 ft. At this altitude, the KA-45 can collect very good imagery for length determinations and species composition. Imagery from 600 ft (or lower) is spectacular, but because flying at this altitude seems to affect the dolphin schools, do so only when the ship is very near or after the ship has passed.

CHALLENGES

Hardware

The cameras are electronically operated and, therefore, subject to unpredictable failures. The extremely humid, tropical conditions that we must operate under wreak havoc on all hardware and film, so extra care must be taken to prevent gear from too much exposure to the elements. Obviously, the vertical cameras must operate unprotected, but a new deflector added to the camera mount coupled with the custom-fit water-proof bags should keep some of the moist air out.

This year, we are armed with the knowledge gained from various systems failures that occurred during MOPS '87. An

experienced PRSG team member will be present on each leg of the Jordan cruise, however, unfamiliar problems will undoubtedly arise. Several new components to the photographic system have not yet been tested in the tropical environment: the A to D converter for the radar altimeter, the data acquisition system, and a new control box. If the experienced member of the PRSG team is unable to repair equipment, radio the Center. If there is a complicated, insurmountable problem, use INMARSAT to communicate with designated support personnel on land. Because most of our photographic system has been duplicated (and even triplicated), flights should not be interrupted, repairs can be made during non-optimal flight hours.

The radar altimeter aboard the helicopter has been sealed against rain, but check the altimeter after significant rain storms.

Software

The data acquisition system is new this year. The back-seat observer will input shutter speeds, f-stops, environmental conditions, sighting and pass numbers, and notes. The software will automatically input data when the cameras fire, recording altitude, time and date for each picture taken. In case of system failure, record all of this data by hand on the forms provided.

Observer Interactions

Helicopter operations should not affect the normal operations of the observers. The helicopter has the potential of biasing the data collected by the observers significantly. Keep in mind that a helicopter circling over a school or a patch of fluorescein dye could become a sighting cue, unless you "train" the observers to ignore them. That is, dummy dye markers may be dropped periodically and false circles and passes can occasionally be made by the helicopter. Also, radio transmissions are picked up on the observer's tape player and therefore, these should be kept to a minimum and made somewhat random. Hand-held radios that are brought up to the Flying Bridge by the cruise leader must have their volume settings low enough that none of the observers can detect any traffic between the ship and the helicopter. Additionally, the helicopter cannot be used to find schools for the observers until the school is beyond the beam of the ship. At this point, any schools so identified will have to be considered as "off-effort" sightings. The cruise leader will decide whether the ship will approach an off-effort helicopter sighting in order for the observers to estimate school size. Such off-effort school sizes are necessary to obtain a sufficient sample for school size calibration.

Finally, when the helicopter lands, the ship may need to come into the wind. This could cause the observers to lose a school that they have been tracking, ruin the CAST track data, or cause them to fall behind a school they were about to observe. All of these interactions should be minimized. Ask the cruise leader before the helicopter lands whether or not the observers are working a sighting. Try to accommodate their needs as best you can, but obviously if the helicopter needs to land for safety reasons, it should land without delay.

Logistics

Although schools of all sizes are important, large schools are the hardest to obtain. Perseverance pays off when photographing them. Be creative, experiment with passes at higher altitudes, and be sure to document how much of the school you believe you are covering. After several passes, observe how the school reacts to the approaching ship. There is often a short period of greater school cohesiveness just before the school splits up in response to the vessel's approach.

The statistical design for calibrating observer school size estimates requires that at least 60 dolphin schools be both photographed and estimated by the shipboard observers. Some schools that are photographed will have to be eliminated from the observer calibration experiment because of less than optimum photographic conditions, camera failures, and the like. Keep this information in mind and reach for that extra school or pass.

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